REVIEWS OF GEOPHYSICS AND SPACE PHYSICS, VOL. 21, NO. 6, PAGES 1299-1308, JULY 1983
U.S. NATIONAL REPORT TO INTERNATIONAL UNION OF GEODESY AND GEOPHYSICS 1979-1982

SYNTHETICS AND THEORETICAL SEISMOLOGY

David G. Harkrider

Seismological Laboratory, California Institute of Technology, Pasadena, California 91125

Near Field Synthetics

In the near field, discrete-finite wave number schemes are economic since they involve fewer wave numbers than most wave number integration schemes. The number of wave numbers is determined by the range and the location of artificial reflectors or fictitious sources inherent in discrete wave number techniques. The number and spacing of wave numbers in wave number integration schemes are determined by the desired accuracy.

The vertical integration schemes used in the near field have been either spectral (Apsel,1979,Bouchon,1981) as in the regional techniques or finite-element (Olson,1982) and finite-difference in the time domain as in the Alexseev-Mikhailenko method. The finite element schemes have the disadvantage in that the vertical step size is determined by the desired maximum frequency content, which in turn determines the time step required for stability. This time step is usually many times smaller than the time increment associated with the maximum frequency.

If portions of the vertical velocity and density profile are homogeneous, spectral techniques propagate across the region in one vertical step while the finite element-difference methods reqire many. On the other hand, in the vicinity of moderate vertical gradients the step size or layer thickness of the spectral techniques will be at least as small as the finite element scheme and the number of numerical operations considerably more. Convergence as the number of wave numbers is increased is more straightforward using the spectral schemes and, as one would expect, the number of wave numbers for a given convergence depends on the frequency being evaluated with fewer wave numbers at the lower frequencies.

For the near field and regional synthetic schemes, the wavenumber quadrature of Apsel (1979) and the Fourier Bessel series of Olson (1982) require significantly more wavenumber evaluations than Bouchon's equal interval wavenumber summation. Bouchon (1981) showed that this wavenumber discretization is equivalent to adding an infinite set of specified circular sources about the point source at equal radial intervals. The length of time desired for the point source response governs the minimum distance from these new sources and this determines the wavenumber spacing.

For many problems, a fault is treated as a summation of subfaults which can be considered point sources. Thus there is a need for rapid construction of Green's functions for several different source depths. For codes based on reciprocity, ie. surface source and receiver at depth, such as Apsel (1979) and Olson (1982), the only additional effort for obtaining as many source depth Green's functions as there are vertical integration points is in saving the intermediate values at these points. A similar economy can be obtained using the itrerative reflection and transmission coefficient relations of Kennett.

Kamel and Felsen (1981) presented a hybrid ray-mode formulation for the construction of SH synthetics. Theory, details, and synthetic were given for the complete SH motion at the top of a low velocity surface layer due to a line SH source at depth in the halfspace. The chosen number of ray fields plus the contour of the remainder integral uniquely determine the number of trapped and leaky modes necessary for the complete seismogram. This scheme has the advantage of a generalized or asymptotic ray description for early observation times and of a modal description at later times. A physical interpretation of the formulation is that the constituent local plane waves synthesizing the modes fill the void in spectrum due to take-off angles left vacant at the source by the truncated ray series, and vice versa.

Regional Synthetics

At the regional distances, complete seismograms have been calculated by modal and wave number integration techniques. The vertical integration of both techniques have used either propagator matrices or reflectivity formulations for homogeneous layers.

Dunkin (1965), Knopoff (1964), Thrower (1965), and Gilbert and Backus (1966) presented P-SV formulations which allowed the eigenvalues of multilayered systems to be calculated to almost unlimited high frequencies. Abo Zena (1979) presented an alternative method. One of the advantages of Dunkin's formulation was the use of compound matrices for calculating the vertical eigenfunctions. P-SV eigenfunctions using Dunkin's scheme can be calculated entirely with exponential functions whose value is never greater than one.

Another advantage is that these expressions guarantee convergence of the eigenfunctions at depth even at high frequencies. Harvey (1981) pointed out these expressions were self correcting in that they involve both terms representing integration down from the free-surface and integration up from the half-space. And that when evaluating the eigenfunction near the free surface the downward integration terms dominate and at depth near the terminating half space, the upward integration terms dominate. The most stable form

Paper number 3R0666.
0034-6853/83/003R-0666$15.00

of Dunkin's eigenfunction algorithm is to use Thomson-Haskell matrices from the surface down to the desired depth combined with compound matrices from the half space up to the depth. A similar conclusion was reached by Woodhouse (1980) for his form of the algorithm.

Harvey (1981) modified the eigenfunction expressions so that the same self correcting feature could be used with the Thomson-Haskell layer matrices alone. By using a high velocity terminating half space with a shear velocity greater than any apparent horizontal velocity of interest at the synthesis range, Harvey (1981) calculated regional P-SV and SH synthetics by summing all the "locked modes" in the frequency-phase velocity region of interest. The depth of the half-space was chosen so that arrivals from the bottom were separated from the desired signals.

Herrmann (1979) presented a numerical technique for calculating the SH contribution to tangential displacement due to point dislocation sources. The wave number integral was separated into two branch line integrals and the residue contributions of the real axis poles. The relative contributions of each to the total waveform were calculated and it was found that at short distances, the total integral is required to adequately model the low frequency response of the far field. At large distances, the pole contributions are all that is required for a realistic estimate of the solution; the higher the frequency content of the source and the frequency response of the receiver, the better the pole representation. He also discussed the effect of neglecting the near field P-SV contribution to the solution; in particular, the appearance of non propagating, non causal, early arrivals. The far field SH contribution, which does not have these arrivals seemed to be adequate at distances beyond 2 to 5 source depths for the source durations considered.

Wang and Herrmann (1980) extended the Herrmann (1979) SH wave study to both SH and P-SV wave generation. The P-SV near field term contribution to the tangential displacement field could now be calculated and and it was found that a P-SV arrival really arises to cancel out the non causal arrival introduced by the near field term as previously postulated by Herrmann. Similarly, when the near field contribution of the SH wave to the radial displacement field is neglected, a non progating early arrival exists, especially for the vertical dip slip source.

Fryer (1980) presented an alternative to spectral reflectivity techniques. He advocated the use of the time domain reflectivity coefficient with the solution given as an integral of the coefficient over angle of incidence.

Cormier (1980) formulated and synthesized complete seismograms in the high frequency band appropriate for near and regional distances. The procedure combines the zeroth order in frequency asymptotic solutions to the propagator and fundamental matrices of radially inhomogeneous spherical shells with the stable vector-matrix methods of Abo-Zena (1979). The displacement response is evaluated conveniently by separately calculating the response due to the fundamental Rayleigh pole with one complex ray parameter contour and the response of all the other modes with another contour.

Global Synthetics

Ward (1980) presented the moment tensor source description for the elastic wave potentials in a spherically symmetric slowly varying inhomogeneous medium. The formulation uses the propagator matrix method of solution. This technique is contrasted with that of obtaining the inhomogeneous term for the potential wave equations from the body force and then finding the full solution to the inhomogeneous equations.

Chapman and Woodhouse (1981) extend the symmetries of the first order differential system for elastic waves in plane stratified media to the spherically stratified gravitating system. The symmetry between the propagator and its inverse allowed an analogy to be drawn between the nornal mode solutions and solutions obtained by including the source as an inhogeneous term in the differential system.

Ward (1981) used the results of Chapman and Woodhouse (1981) to transform the propagator matrix solution into a form similar to the normal mode solution in that the source terms of both involve combinations of strain with moment tensor and displacement with force.

Recent papers by Dziewonski and Woodhouse (1982) and Woodhouse (1982) substantially move the routine analysis of long period body waves by the method of normal mode summation toward practical utility.

Kinematic Seismic Sources

Boatwright (1980) investigated the far field body wave radiaton for a class of circular rupture models as a function of takeoff angle, rupture velocity and stopping behavior. Although the rupture slip models were kinematic they were made to resemble previously obtained results from numerical models of dynamic stress relaxation. The concept of characteristic frequency as an estimate of source dimension is also evaluated.

Andrews (1980a) used a coherent plus random model of static slip and stress change in the Fourier wave number domain to relate the spectrum of a stress function on a fault surface with average stress drop as a function of earthquake size and with the number-size distribution of earthquakes. Similar results were obtained using the self-similar irregularity concept of fractals.

Andrews (1981) extended the self similar concept to the time dependent case with the assumption that on a fault with self similar geometric irregularities, the slip velocity as a function of space and time is self-affine. This kinematic construction was used to obtain the expected far field and near field spectrum.

Using the discrete wave number technique of Bouchon (1979) Chouet (1982) calculated the dynamic free surface near field of a tensile crack nucleating over a circular and rectangular surface at depth in a homogeneous half-space.

Dynamic Seismic Sources

Replacing the initial value volume integral by a surface integral of the stress pulse, Stevens (1980) easily evaluated the seismic radiation generated by the sudden creation of a spherical cavity in an arbitrarily prestressed elastic medium. The advantage of this technique is that

all one needs to know is the stress drop on the cavity surface whereas the initial value method requires the solution of the static problem in order to evaluate the initial value volume integral.

Stevens (1982) formulated the solution for the seismic radiation from an arbitrarily growing spherical cavity in an arbitrarily prestressed medium as a set of coupled Volterra integral equations. Numerical solutions of these equations are used to compute wave forms for several stress fields and growth rates.

Burridge et al. (1979) numerically investigated the integral equation solution to a semi-infinite Mode II shear crack driven at constant speed by a point load on the surface following the tip at a constant distance.

Knopoff and Chatterjee (1982) explored the analytic solutions to the two-dimensional crack problems of antiplane strain rupture initiating at a point in the presence of dynamical friction and studied the influence of cohesion on the rupture process.

Das (1980) presented a numerical scheme for determining source time functions and rupture histories for three dimensional shear cracks. The method is an extension of the boundary-integral method and as applied here is a discretization of the elastodynamic representation theorem using closed form expressions for the Green's function obtained by Richards (1979). These solutions of Lamb's problem for surface displacements due to surface point forces on an elastic halfspace are expressed in terms of simple trigometric functions and square roots.

Das (1981) applied this technique to the spontaneous rupture over crack planes of constant yield strength and constant dynamic stress drop. Slip and rupture histories were obtained for infinite, semi-infinite, and finite rectangular cracks.

Using a finite difference scheme, Virieux and Madariaga (1982) studied spontaneous rupture propagation in two and three dimensions. A maximum stress criteria was used for two types of nucleation; an instantaneously formed crack in a uniformly prestressed medium and the triggering of a preexisting crack.

Using a three dimensional finite difference code similar to Virieux and Madariaga (1982), Day (1982) investigated the effect of fault length and width on slip functions for a simple shear crack model. The rupture velocity was specified as well as the dynamic stress drop. From the numerical results of this driven dynamic model and with comparisons to simpler analytic models, Day was able to develop closed form expressions for static slip, slip rise time, and slip velocity intensity as a function of fault geometry.

Seismic Source Analogues

Israel and Nur (1979), using a one-dimensional continuum model in which stress and strength varied along the fault, numerically investigated their effect on slip histories along the fault with the method of characteristics.

Landoni and Knopoff (1981) numerically investigated the conditions for growing cracks using a one-dimensional model with stress drop a function of relative crack displacement.

Burridge and Moon (1981) simulated numerically a scalar analogue for a rupturing seismic fault plane in a whole space. The rupture spreads with the wave speed and is evaluated by a discretized version of the kernel of the time-areal integral equaton for the displacement on the fault.

Source Path Coupling

Once the displacement and stress fields have been calculated for realistic source models involving processes too complex to be expressed analytically, the usual procedure has been to obtain an equivalent point source by either forming higher order moment tensors for the source displacement field or multipole expansions of the source potentials. The higher order moment tensors or multipole potentials are readily incorporated into codes for forming synthetics on vertically inhomogeneous half-spaces or radially inhomogeneous spherical earth models.

Stump and Johnson (1982) presented the first, second, and third degree moment tensor components for a finite propagating plane shear fault. The convergence of the moment tensor series was investigated in terms of frequency, azimuth, and fault model.

Bache et al. (1982) presented an alternate technique where non-linear explosion calculations are coupled into the propagation medium using the Elastodynamic Representation Theorem. The finite-difference source calculation included non-linear constitutive relations and the interaction with the free surface. The cylindrically axisymmetric displacement and stress calculations were carried out to a cylindrical surface in the linear region surrounding the explosion. The Green's function used in the Representation Theorem surface integration over the cylinder were for Rayleigh waves on a vertically inhomogeneous half-space and the resulting synthetics demonstrated the effects of non-linear explosion phenomena on the generation of Rayleigh waves. This approach has also been used in the excitation of teleseismic body waves from complex explosion calculations involving free surface spallation.

For sources in complex regions where the geometry is such that the strength and time history of the upgoing radiation is distinctly different than that of the downgoing radiaton, but otherwise regular in the linear propagation region, it is simpler to model the propagation effects of upgoing and downgoing source radiation separately and then combine the contributions for a given source. Harkrider (1981) presented the formulation for such a separation of effects for Rayleigh waves generated by underground explosions and calculated synthetics as a function of source depth in a one layer half-space. Other applications proposed for this separation of source effects are propagation models where lateral complexities separately modify the propagation waves generated by the source even though the source radiation is vertically homogeneous.

Lateral Inhomogenities And Transition Zones

Schlue (1979) presented the finite element stiffness and mass matrices for the propagation of

spectral Rayleigh and Love wave modes in three-dimensional earth models which are laterally heterogeneous. Schlue (1981) completed the development by giving the boundary stiffness matrix between the laterally homogeneous and inhomogeneous zones.

Using the decomposition of Rayleigh waves into inhomogeneous P and SV waves, Chen and Alsop (1979) gave a procedure for determining the approximate reflection and transmission of obliquely incident Rayleigh waves at a vertical discontinuity between two welded quarter-spaces.

By a generalization of the phase integral method, Frazer and Phinney (1980) presented a technique for computing finite frequency seismograms for a medium whose velocity and density are continuous functions in two or three-dimensions.

Free Oscillations

Dahlen in a series of papers investigated the effect of aspherical splitting on the apparent amplitude, central frequency, and half width of an unresolved isolated multiplet. Using perturbation theory, Dahlen (1979a) determined this effect for both single stations and spectral stacks on a laterally heterogeneous earth model including ellipticity but with anelasticity a function of radius only. Dahlen (1979b) demonstated that for an ellipsoidal earth with no other deviation from sphericity, the appearance of a single or broadened peak as in Dahlen (1979a) is due to cancellation among neighboring singlets. Since the single peak approximation used in Dahlen (1979a,b) breaks down near the epicenter and antipode, Dahlen (1980) obtained an asymptotic formula valid over the entire free surface. Finally, Dahlen (1981) extended his previous results for a smooth laterally heterogeneous earth whose attenuation structure is spherical to an earth whose attenuation structure is laterally variable.

The question of coupling of nearly resonant quasidegenerate multiplets was considered by Woodhouse (1980). The coupling influences considered were those of rotation and ellipticity with a spherically symmetric attenuation structure.

Stifler and Bolt (1981) investigated splitting of low order torsional eigenvibrations using a finite element model of ellipticity and the structural contrasts between oceans and continents.

Chao (1981) using group theory established the eigenfrequency splitting rules for an axisymmetric earth, a rotating earth, and an arbitrary earth. In addition group theory was used to determine the coupling of the unperturbed spherical modes by ellipticity, pear shapedness, and rotation.

Wahr (1981) developed an expansion formalism for the normal modes of a rotating earth by transforming the three-dimensional equations of motion into a six-dimensional system with its own inner product which includes the elastic gravitational operator as part of the inner product definition. This expansion completely decoupled all non-trivial normal modes.

Chao (1982) obtained equivalent results using the method of spectral decomposition for linear operators formulated in Dirac's bra-ket notation first for a non-rotating earth and then, by extending the formulation to operators quadratic in the eigenvalues, to the rotating earth.

Morris and Geller (1982) compared first-order degenerate perturbation theory and Rayleigh-Ritz variational procedures in a calculation of some of the low order toroidal modes of a sphere consisting of hemispheres with different elastic properties.

Seismic Inversion

Silver and Jordan (1982) presented a method for estimating scalar seismic moments from noisy seismic data. The technique also includes the effect of transfer - function errors. The squares of the two scalar moments are related to the squared Euclidian norm and the squared trace of the spectral moment - rate tensor. The basic data function used is the cross-spectrum for seismogram pairs integrated over narrow frequency intervals.

Bolt and Brillinger (1979) present an estimation procedure for determining the amplitudes, frequencies, and damping factors of free oscillations with their variances using complex demodulation and non linear least squares.

Chao and Gilbert (1980) represent a seismogram as an autoregressiive time series and use Prony's method to obtain the complex frequencies from the series. Their algorithm is devised so that spectral peaks can be analysed individually or in small groups. In addition it decouples the problem of estimating amplitude and complex frequency.

Coen (1981) developed an algorithm for inferring the shear modulus and density profiles from the surface displcement field due to an impulsive surface SH line source.

Acknowledgment This research was partially supported by the Advanced Research Projects Agency of the Department of Defense and was monitored by the Air Force Office of Scientific Research under Contract No. F49620-81-C-0008. Contribution No. 3892, Division of Geological and Planetary Sciences, California Institute of Technology, Pasadena, California 91125.

References

Abo-Zena, A., Dispersion function computations for unlimited frequency values, Geophys. J. R. astr. Soc., 58, 91-105, 1979.

Abo-Zena, A., Strike-slip on a fault caused by an oblique wave, Bull. Seism. Soc. Am., 71, 405-422, 1981.

Acharya, H. K., Regional variations in the rupture-length magnitude relationships and their dynamical significance, Bull. Seism. Soc. Am., 69, 2063-2084, 1979.

Achenbach, J. D., A. Norris, and K. Viswanathan, Mapping of crack edges by seismic methods, Bull. Seism. Soc. Am., 72, 779-792, 1982.

Aki, K., Characterization of barriers on an earthquake fault, J. Geophys. Res., 84, 6140-6148, 1979.

Aki, K., Re-evaluation of seismic stress drop and seismic energy using a new model of earthquake faulting, Source Mechanism and Earthquake Prediction, C. J. Allegre, ed., CNRS, Paris, 23-50, 1980.

Aki, K., Attenuation and scattering of short-period seismic waves in the lithosphere, Identification of Seismic Sources - Earthquake or Underground Explosion, E. S. Huseby and S. Mykkeltveit, eds., D. Reidel Publ. Co., Boston, 515-541, 1981.

Aki, K., Strong motion prediction using mathematical modeling techniques, Bull. Seism. Soc. Am., 72, S29-S41, 1982.

Aki, K., and P. G. Richards, Quantitative Seismology, I, and II, W. H. Freeman and Co., 913 pp., 1980.

Alam, M. A., and C. J. Sicking, Recursive removal and estimation of minimum-phase wavelet, Geophys., 46, 1379-1391, 1981.

Aminzadeh, F., and J. M. Mendel, On the Bremmer series decomposition: Equivalence between two different approaches, Geophy. Prosp., 28, 71-84, 1980.

Aminzadeh, F., and J. M. Mendel, Filter design for suppression of surface multiples in a non-normal incidence seismogram, Geophys. Prosp., 29, 835-852, 1981.

Aminzadeh, F., and J. M. Mendel, Non-normal incidence state-space model and line source reflection syntheric seismograms, Geophys. Prosp., 30, 451-568, 1982.

Anderson, D. L., and A. M. Dziewonski, Upper mantle anisotropy: evidence from free oscillations, Geophys. J. R. astr. Soc., 69, 383-404, 1982.

Anderson, D. L., and J. B. Minster, The frequency dependence of Q in the Earth and implications for mantle rheology and Chandler wobble, Geophys. J. R. astr. Soc., 58, 431-440, 1979.

Anderson, D. L., and J. B. Minster, Seismic velocity, attenuation and rheology of the upper mantle, Source Mechanism and Earthquake Prediction, C. J. Allegre, ed., CNRS, Paris, 13-22, 1980.

Anderson, K. R., Robust earthquake location using M-estimates, Phys. Earth and Planet. Int., 30, 119-130, 1982.

Anderson, J. G., Estimating the seismicity from geological structure for seismic-risk studies, Bull. Seism. Soc. Am., 69, 135-158, 1979.

Andrews, D. J., Fault impedance and earthquake energy in the Fourier transform domain, Bull. Seism. Soc. Am., 70, 1980.

Andrews, D. J., A stochastic fault model, 1. Static case, J. Geophys. Res., 85, 3867-3877, 1980a.

Andrews, D. J., Fault impedance and earthquake energy in the Fourier transform domain, Bull. Seism. Soc. Am., 70, 1683-1698, 1980b.

Andrews, D. J., A stochastic fault model, 2. Time-dependent case, J. Geophys. Res., 86, 10821-10834, 1981.

Apsel, R. J., Dynamic Green's functions for layered media and applications to boundary value problems, Ph.D. Dissertation, Department of Applied Mechanics and Engineering Sciences, University of California, San Diego, 1979.

Archuleta, R. J., and S. M. Day, Dynamic rupture in a layered medium: The 1966 Parkfield earthquake, Bull. Seism. Soc. Am., 70,671-689, 1980.

Archuleta, R. J., Analysis of near-source static and dynamic measurements from the 1979 Imperial Valley earthquake, Bull. Seism. Soc. Am., 72, 1927-1956, 1982.

Archuleta, R. J., and S. M. Day, Dynamic rupture in a layered medium: the 1966 Parkfield earthquake, Bull. Seism. Soc. Am., 70, 671-689, 1980.

Archuleta, R. J., and S. H. Hartzell, Effects of fault finiteness on near-source ground motion, Bull. Seism. Soc. Am., 71, 939-957, 1981.

Armstrong, B. H., Frequency-independent background internal friction in heterogeneous solids, Geophys., 45, 1042-1054, 1980.

Bache, T. C., S. M. Day, and H. J. Swanger, Rayleigh wave synthetic seismograms from multi-dimensional simulations of underground explosions, Bull. Seism. Soc. Am., 72, 15-28, 1982.

Backus, G. E., Reply: Limits of validity of first-order perturbation theory for quasi-P velocity in weakly anisotropic media, J. Geophys. Res., 87, 4641-4644, 1982.

Barcilon, V., Ideal solution of an inverse normal mode problem with finite spectral data, Geophys. J. R. astr. Soc., 56, 399-408, 1979.

Barker, T. G., and J. B. Minster, Far-field and near-field radiation from a growing and propagating relaxation source, Wave Motion, 2, 231-245, 1980.

Berger, J., D. C. Agnew, R. L. Parker, and W. E. Farrell, Seismic system calibration: 2. Cross-spectral calibration using random binary signals, Bull. Seism. Soc. Am., 69, 271-288, 1979.

Berryhill, J. R., Wave-equation datuming, Geophys., 44, 1329-1344, 1979.

Berryman, J. G., Long-wave elastic anisotropy in transversely istropic media, Geophys., 44, 896-917, 1979.

Berryman, J. G., and R. R. Greene, Discrete inverse methods for elastic waves in layered media, Geophys., 45, 213-233, 1980.

Bickel, S. H., The effects of noise on minimum-phase Vibroseis deconvolution, Geophys., 47, 1174-1184, 1982.

Bleistein, N., and J. K. Cohen, Direct inversion procedure for Claerbout's equations, Geophys., 44, 1034-1040, 1979.

Bleistein, N., and J. K. Cohen, Velocity inversion - Present status, new directions, Geophys., 47, 1497-1511, 1982.

Boatwright, J., Preliminary body-wave analysis of the St. Elias, Alaska earthquake of February 28, 1979, Bull. Seism. Soc. Am., 70, 419-436, 1980.

Boatwright, J., A spectral theory for circular seismic sources; simple estimates of source dimensions, dynamic stress drop, and radiated seismic energy, Bull. Seism. Soc., 70, 1-27, 1980.

Boatwright, J., Quasi-dynamic models of simple earthquakes: application to an aftershock of the 1975 Oroville, California, earthquake, Bull. Seism. Soc. Am., 71, 69-94, 1981.

Boatwright, J., A dynamic model for far-field acceleration, Bull. Seism. Soc. Am., 72, 1049-1068, 1982.

Bolt, B. A., and D. R. Brillinger, Estimation of uncertainties in eigenspectral estimates from decaying geophysical time series, Geophys. J., R. astr. Soc., 59, 593-603, 1979.

Boore, D. M., S. C. Harmsen, and S. T. Harding, Wave scattering from a step change in surface topography, Bull. Seism. Soc. Am., 71, 117-125, 1981.

Borcherdt, R. D., Reflection-refraction of general P- and type-I S-waves in elastic and anelastic solids, Geophys. J. R. astr. Soc., 70, 621-638, 1982.

Bouchon, M., Discrete wave number representation of elastic wave fields in three-space dimensions, J. Geophys. Res., 84, 3609-3614, 1979.

Bouchon, M., Predictability of ground displacement and velocity near an earthquake fault: an example: the Parkfield earthquake of 1966, J. Geophys. Res., 84, 6149-6156, 1979.

Bouchon, M., Calculation of complete seismograms for an explosive source in a layered medium, Geophys., 45, 197-203, 1980.

Bouchon, M., The motion of the ground during an earthquake. 1. The case of a strike slip fault, J. Geophys. Res., 85, 356-366, 1980.

Bouchon, M., The motion of the ground during an earthquake. 2. The case of a dip slip fault, J. Geophys. Res., 85, 367-375, 1980.

Bouchon, M., and K. Aki, Simulation of long-period, near-field motion for the great California earthquake of 1857, Bull. Seism. Soc. Am., 70, 1669-1682, 1980.

Bouchon, M., A simple method to calculate Green's functions for elastic layered media, Bull. Seism. Soc. Am., 71, 959-971, 1981.

Bouchon, M., The complete synthesis of seismic crustal phases at regional dis,tances J. Geophys. Res., 87, 1735-1741, 1982.

Bouchon, M., and K. Aki, Simulation of long-period, near-field motion for the Great California Earthquake of 1857, Bull. Seism. Soc. Am., 70, 1669-1682, 1980.

Bouchon, M., and K. Aki, Strain, tilt, and rotation associated with strong ground motion in the vicinity of earthquake faults, Bull. Seism. Soc. Am., 72, 1717-1738, 1982.

Brillinger, D. R., A. Udias, and B. A. Bolt, A probability model for regional focal mechanism solutions, Bull. Seism. Soc. Am., 70, 149-170, 1980.

Brocher, T. M., and R. A. Phinney, Inversion of slant stacks using finite-length record sections, J. Geophys. Res., 86, 7065-7072, 1981.

Brocher, T. M., and R. A. Phinney, A ray parameter-intercept time spectral ratio method for seismic reflectivity analysis, J. Geophys. Res., 86, 7865-7873, 1981.

Brocher, T. M., W. C. Kempner, and J. F. Gettrust, A comparison of synthetic P-tau sections for proposed models of two ophiolites, J. Geophys. Res., 87, 9355-9364, 1982.

Brown, R. J. S., Connection between formation factor for electrical resistivity and fluid-solid coupling factor in Biot's equations for acoustic waves in fluid-filled porous media, Geophys., 45, 1269-1275, 1980.

Brune, J. N., Implications of earthquake triggering and rupture propagation for earthquake prediction based on premonitory phenomena, J. Geophys. Res., 84, 2195-2198, 1979.

Buland, R., Towards locating earthquakes in a laterally heterogeneous medium, Phys. Earth and Planet. Int., 30, 157-160, 1982.

Burdick, L. J., and D. V. Helmberger, Time functions appropriate for nuclear explosions, Bull. Seism. Soc. Am., 69, 957-973, 1979.

Burdick, L. J., and J. A. Orcutt, A comparison of the generalized ray and reflectivity methods of waveform synthesis, Geophys. J. R. astr. Soc. 58, 261-278, 1979.

Burridge, R., G. Conn, and L. B. Freund, The stability of a rapid mode II shear crack with finite cohesive traction, J. Geophys. Res., 85, 2210-2222, 1979.

Burridge, R., F. Mainardi, and G. Servizi, Soil amplification of plane seismic waves, Phys. Earth Planet. Inter., 22, 122-136, 1980.

Burridge, R., and R. Moon, Slipping on a frictional fault plane in three dimensions: a numerical simulation of a scalar analogue, Geophys. J. R. astr. Soc., 67, 325-342, 1981.

Burridge, R., and C. A. Vargas, The fundamental solution in dynamic poroelasticity, Geophys. J. R. astr. Soc., 58, 61-90, 1979.

Butler, R., Shear-wave travel times from SS, Bull. Seism. Soc. Am., 69, 1715-1732, 1979.

Butler, R., G. S. Stewart, and H. Kanamori, The July 27, 1976 Tangshan, China earthquake - a complex sequence of intraplate events, Bull. Seism. Soc. Am., 69, 207-220, 1979.

Butler, R., and H. Kanamori, Long-period ground motion from a great earthquake, Bull. Seism. Soc. Am., 70, 943-961, 1980.

Butler, R., and L. Ruff, Teleseismic short-period amplitudes: source and receiver variations, Bull. Seism. Soc. Am., 70, 831-850, 1980.

Byun, B. S., Seismic parameters for media with elliptical velocity dependencies, Geophys., 47, 1621-1626, 1982.

Campbell, K. W., Bayesian analysis of extreme earthquake occurrences. Part I. Probabilistic hazard model, Bull. Seism. Soc., 72, 1689-1705, 1982.

Cara, M., and J. B. Minster, Multi-mode analysis of Rayleigh type Lg. Part 1. Theory and applicability of the method, Bull. Seism. Soc. Am., 71, 973-1002, 1981.

Carter, J. A., and L. N. Frazer, Rapid F-K migration of zero offset marine reflection data, J. Geophys. Res., 87, 9365-9373, 1982.

Castle, R. J., Wave-equation migration in the presence of lateral velocity variations, Geophys., 47, 1001-1011, 1982.

Chao, B. F., Symmetry and terrestrial spectroscopy, Geophys. J. R. astr. Soc., 66, 285-312, 1981.

Chao, B. F., Excitation of normal modes on non-rotating and rotating earth models, Geophys. J. R. astr. Soc., 68, 293-315, 1982.

Chao, B. F., and F. Gilbert, Autoregressive estimation of complex eigenfrequencies in low frequency seismic spectra, Geophys. J. R. astr. Soc., 63, 641-657, 1980.

Chapman, C. H., On impulsive wave propagation in a spherically symmetric model, Geophys. J. R. astr. Soc., 58, 229-234, 1979.

Chapman, C. H., Long-period corrections to body waves: theory, Geophys. J. R. astr. Soc., 64, 321-372, 1981.

Chapman, C. H., and R. Drummond, Body wave seismograms in inhomogeneous media using Maslov asymptotic theory, Bull. Seism. Soc. Am., 72, S277-S317, 1982.

Chapman, C. H., and J. H. Woodhouse, Symmetry of the wave equation and excitation of body waves, Geophys. J. R. astro. Soc., 65, 777-782, 1981.

Chen, T. C., and L. E. Alsop, Reflection and transmission of obliquely incident Rayleigh waves at a vertical discontinuity between two welded quarter-spaces, Bull. Seism. Soc. Am., 69, 1409-1423, 1979.

Cheng, C. H., M. Nafi Toksoz, and M. E. Willis, Determination of in situ attenuation from full waveform acoustic logs, J. Geophys. Res., 87, 5477-5484, 1982.

Chin, R. C. Y., Wave propagation in viscoelastic media, Physics of the Earth's Interior, Course LXXVIII, A. Dziewonski and E. Boschi, eds., North Holland Publ. Co., New York, 213-246, 1980.

Choate, W. C., A fast algorithm for normal

incidence seismograms, Geophys., 47, 196-202, 1982.

Choi, A. P., and F. Hron, Amplitude and phase shift due to caustics, Bull. Seism. Soc. Am., 71, 1445-1461, 1981.

Chou, C. W., and J. R. Booker, A Backus-Gilbert approach to inversion of travel-time data for three-dimensional velocity structure, Geophys. J. R. astr. Soc., 59, 325-344, 1979.

Chouet, B., Sources of seismic events in the cooling Lava Lake of Kilauea Iki, Hawaii, J. Geophys. Res., 84, 2315-2330, 1979.

Chouet, B., Free displacements in the near field of a tensile crack expanding in three dimensions, J. Geophys. Res., 87, 3868-3872, 1982.

Choy, G. L., and J. Boatwright, Broadband analysis of the extended foreshock sequence of the Miyagi-Oki earthquake of 12 June 1978, Bull. Seism. Soc. Am., 72, 2017-2036, 1982.

Choy, G. L., V. F. Cormier, R. Kind, G. Muller, and P. G. Richards, A comparison of synthetic seismograms of core phases generated by the full wave theory and by the reflectivity method, Geophys. J. R. astr. Soc., 61, 21-39, 1980.

Christoffersson, A., Statistical models for seismic magnitude, Phys. Earth Planet. Inter., 21, 237-260, 1980.

Chun, J. H., and C. A. Jacewitz, Fundamentals of frequency domain migration, Geophys., 46, 717-733, 1982.

Cipar, J., Source processes of the Haicheng, China earthquake from observations of P and S waves, Bull. Seism. Soc. Am., 69, 1903-1916, 1979.

Cipar, J., Teleseismic observations of the 1976 Friuli, Italy earthquake sequence, Bull. Seism. Soc. Am., 70, 963-983, 1980.

Cipar, J., Broadband time domain modeling of earthquakes from Friuli, Italy, Bull. Seism. Soc. Am., 71, 1215-1231, 1981.

Clayton, R. W., and B. Engquist, Absorbing boundary conditions for wave-equation migration, Geophys., 45, 895-904, 1980.

Clayton, R. W., and G. A. McMechan, Inversion of refraction data by wave field continuation, Geophys., 46, 860-868, 1981.

Clayton, R. W., and R. H. Stolt, A Born-WKBJ inversion method for acoustic reflection data, Geophys., 46, 1559-1567, 1981.

Coen, S., Density and compressibility profiles of a layered acoustic medium from precritical incidence data, Geophys., 46, 1244-1246, 1981.

Coen, S., The inverse problem of the shear modulus profile of a layered earth, J. Geophys. Res., 85, 5364-5366, 1980.

Coen, S., The inverse problem of the shear modulus and density profiles of a layered earth, J. Geophys. Res., 86, 6052-6056, 1981.

Coen, S., The inverse problem of the density and bulk modulus profiles of a layered fluid, Bull. Seism. Soc. Am., 72, 809-820, 1982.

Coen, S., Velocity and density profiles of a layered acoustic medium from common source-point data, Geophys., 47, 898-905, 1982.

Cohen, J. K., and N. Bleistein, Velocity inverson procedure for acoustic waves, Geophys., 44, 1077-1087, 1979.

Cohen, S. C., Postseismic surface deformations due to lithospheric and asthenospheric viscoelasticity, Geophys. Res. Lett., 6, 129-131, 1979.

Cohen, S. C., Numerical and laboratory simulation of fault motion and earthquake occurrence, Rev. Geophys. Space Phys., 17, 61-72, 1979.

Cohen, S. C., Postseismic viscoelastic surface deformation and stress. 1. Theoretical considerations, displacement, and strain calculations, J. Geophys. Res., 85, 3131-3150, 1980.

Cohen, S. C., Postseismic viscoelastic deformation and stress. 2. Stress theory and computation; dependence of displacement, strain, and stress on fault parameters, J. Geophys. Res., 85, 3151-3158, 1980.

Cohen, S. C., A multilayer model of time dependent deformation following an earthquake on a strike slip fault, J. Geophys. Res., 87, 5409-5421, 1982.

Comer, R. P., Tsunami height and earthquake magnitude: theoretical basis for an empirical relation, Geophys. Res. Lett., 7, 445-448, 1980.

Cormier, V. F., The synthesis of complete seismograms in an earth model specified by radially inhomogeneous layers, Bull. Seism. Soc. Am., 70, 691-716, 1980.

Cormier, V. F., Theoretical body wave interactions with upper mantle structure, J. Geophys. Res., 86, 1673-1678, 1981.

Crampin, S., and B. J. Radovich, Interpretation of synthetic common-depth-point gathers for a single anisotropic layer, Geophys., 47, 323-335, 1982.

Crampin, S., R. A. Stephen, and R. McConigle, The polarization of P-waves in anisotropic media, Geophys. J. R. astr. Soc., 68, 477-485, 1982.

Cunningham, A. B., Some alternate vibrator signals, Geophys., 44, 1901-1921, 1979.

Dahlen, F. A., The spectra of unresolved split normal mode multiplets, Geophys. J. R. astr. Soc., 58, 1-33, 1979.

Dahlen, F. A., Exact and asymptotic synthetic multiplet spectra on an ellipsoidal earth, Geophys. J. R. astr. Soc., 59, 19-42, 1979.

Dahlen, F. A., Geometrical optics and normal mode perturbation theory: A comparison in one dimension, Bull. Seism. Soc. Am., 69, 1391-1407, 1979.

Dahlen, F. A., Addendum to 'Excitation of the normal modes of a rotating earth model by an earthquake fault' Geophys. J. R. astr. Soc., 62, 719-721, 1980.

Dahlen, F. A., A uniformly valid asymptotic representation of normal mode multiplet spectra on a laterally hererogeneous Earth, Geophys. J. R. astr. Soc., 62, 225-247, 1980.

Dahlen, F. A., Splitting of the free oscillations of the earth, Physics of the Earth's Interior, Course LXXVIII, A. Dziewonski and E. Boschi, eds., North Holland Publ. Co., New York, 82-126, 1980.

Dahlen, F. A., The free oscillations of an anelastic aspherical earth, Geophys. J. R. astr. Soc., 66, 1-22, 1981.

Dahlen, F. A., The effect of data windows on the estimation of free oscillation parameters, Geophys. J. R. astr. Soc., 69, 537-549, 1982.

Dahlen, F. A., and R. V. Sailor, Rotational and elliptical splitting of the free oscillations of the Earth, Geophys. J. R. astr. Soc., 58, 609-623, 1979.

Dainty, A. M., A scattering model to explain seismic Q observations in the lithosphere between 1 and 30 Hz, Geophys. Res. Lett., 8, 1126-1128, 1981.

Das, S., A numerical method for determination of source time functions for general three-dimensional rupture propagation, Geophys. J. R. astr. Soc., 62, 591-604, 1980.

Das, S., Three-dimensional spontaneous rupture propagation and implications for the earthquake source mechanism, Geophys. J. R. astr. Soc., 67, 375-393, 1981.

Das, S., and C. H. Scholz, Theory of time-dependent rupture in the earth, J. Geophys. Res., 86, 6039-6051, 1981.

Das, S., Appropriate boundary conditions for modeling very long earthquakes and physical consequences, Bull. Seism. Soc. Am., 72, 1911-1926, 1982.

Day, S. M., Three-dimensional finite difference simulation of fault dynamics rectangular faults with fixed rupture velocity, Bull. Seism. Soc. Am., 72, 705-727, 1982.

Day, S. M., Three-dimensional simulation of spontaneous rupture: the effect of nonuniform prestress, Bull. Seism. Soc. Am., 72, 1881-1902, 1982.

Diebold, J. B., and P. L. Stoffa, The traveltime equation, tau-p mapping, and inversion of common midpoint data, Geophys., 46, 238-254, 1981.

Dorman, L. M., A linear relationship between earth models and seismic body wave data, Geophys. Res. Lett., 6, 132-134, 1979.

Dorman, L. M., and R. S. Jacobson, Linear inversion of body wave data - Part 1: Velocity structure from traveltimes and ranges, Geophys., 46, 138-151, 1981.

Drake, L. A., Love and Rayleigh waves in an irregular soil layer, Bull. Seism. Soc. Am., 70, 571-582, 1980.

Drake, L. A. and B. A. Bolt, Love waves normally incident at a continental boundary, Bull. Seism. Soc. Am., 70, 1103-1123, 1980.

Drowley, D. S., and K. C. McNally, Location of earthquake swarm events near Palmdale, California, using a linear gradient velocity model, Bull. Seism. Soc. Am., 70, 1980.

Dubrulle, A. A., and J. Gazdag, Migration by phase shift - An algorithmic description for array processors, Geophys., 44, 1661-1666, 1979.

Dunkin, J. W., Computation of modal solutions in layered, elastic media at high fequencies, Bull. Seism. Soc. Am., 55, 335-358, 1965.

Dutta, N. C., and H. Ode, Attenuation and dispersion of compressional waves in fluid-filled porous rocks with partial gas saturation (White model) - Part 1: Biot theory, Geophys., 44, 1777-1788, 1979.

Dziewonski, A. M., and D. L. Anderson, Preliminary reference Earth model, Phys. Earth Planet. Inter., 25, 297-356, 1981.

Dziewonski, A. M., T.-A. Chou, and J. H. Woodhouse, Determination of earthquake source parameters from waveform data for studies of global and regional seismicity, J. Geophys. Res., 86, 2825-2852, 1981.

Dziewonski, A. M., T.-A. Chou, and J. H. Woodhouse, Determination of source mechanism and hypocentral coordinates from waveform data, Identification of Seismic Sources - Earthquake or Underground Explosion, E. S. Huseby and S. Mykkeltveit, eds., D. Reidel Publ. Co., Boston, 233-254, 1981.

Dziewonski, A. M., and J. M. Steim, Dispersion and attenuation of mantle waves through waveform inversion, Geophys. J. R. astr. Soc., 70, 503-527, 1982.

Dziewonski, A. M., and J. H. Woodhouse, Studies of the seismic source using normal mode theory, Physics of the Earth's Interior, Course LXXXV, H. Kanamori and E. Boschi, eds., North Holland Publ. Co., New York, in press, 1982.

Ebel, J. E., Source processes of the 1965 New Hebrides Islands earthquakes inferred from teleseismic waveforms, Geophys. J. R. astr. Soc., 63, 381-403, 1980.

Ehrenberg, J. E., and E. N. Hernandez, Covariance-invariant digital filtering-A better digital processing technique for ground motion studies, Bull. Seism. Soc. Am., 71, 1361-1367, 1981.

Eisner, E., The Kunetz relations, Geophys. Prosp., 29, 529-532, 1981.

Eissler, H., and H. Kanamori, A large normal-fault earthquake at the junction of the Tonga trench and the Louisville ridge, Phys. Earth and Planet. Int., 29, 161-172, 1982.

Emerman, S. H., W. Schmidt, and R. A. Stephen, An implicit finite-difference formulation of the elastic wave equation, Geophys., 47, 1521-1526, 1982.

Estevez, R., and J. F. Claerbout, Wide-angle diffracted multiple reflections, Geophys., 47, 1255-1272, 1982.

Evernden, J. F., and W. M. Kohler, Further study of spectral composition of P codas of earthquakes and explosions, Bull. Seism. Soc. Am., 69, 483-511, 1979.

Farrell, W. E., and J. Berger, Seismic system calibration: 1. Parametric models, Bull. Seism. Soc. Am., 69, 251-270, 1979.

Fehler, M., Interaction of seismic waves with a viscous liquid layer, Bull. Seism. Soc. Am., 72 55-72, 1982.

Felsen, L. B., Hybrid ray-mode fields in inhomogenious waveguides and ducts, J. Acoust. Soc. Am., 69, 352-361, 1981.

Felsen, L. B., and T. Ishihara, Hybrid ray-mode formulation of ducted propagation, J. Acoust. Soc. Am, 65, 595-607, 1979.

Ferrick, M. G., A. Qamar, and W. F. St. Lawrence, Source mechanism of volcanic tremor, J. Geophys. Res., 87, 8675-8683, 1982.

Fitch, T. J., D. W. McCowan, and M. W. Shields, Estimation of the seismic moment tensor from teleseismic body wave data with applications to intraplate and mantle earthquakes, J. Geophys. Res., 85, 3817-3828, 1980.

Fletcher, J. B., Spectra from high-dynamic range digital recordings of Oroville, California aftershocks and their source parameters, Bull. Seism. Soc. Am., 70, 735-755, 1980.

Frazer, L. N., A new derivation of the displacement potentials for motion in a homogeneous isotropic elastic medium, Geophys. J. R. astr. Soc., 59, 389-397, 1979.

Frazer, L. N., and R. A. Phinney, The theory of finite frequency body wave synthetic seismograms in inhomogeneous elastic media, Geophys. J. R. astr. Soc., 63, 691-717, 1980.

Frazer, L. N., Invariant expressions for elastic radiation from a fault with prescribed slip, Geophys. J. R. astr. Soc., 70, 529-533, 1980.

Freund, L. B., The mechanics of dynamic shear crack propagation, J. Geophys. Res., 84, 2199-2209, 1979.

Fryer, G. J., A slowness approach to the reflectivity method of seismogram synthesis, Geophys. J. R. astr. Soc., 63, 747-758, 1980.

Ganley, D. C., A method for calculating synthetic seismograms which include the effects of absorption and dispersion, Geophys., 46, 1100-1107, 1981.

Garmany, J., Amplitude constrants in linear inversons of seismic data, J. Geophys. Res., 87, 8426-8434, 1982.

Garmany, J., J. A. Orcutt, and R. L. Parker, Travel time inversion: A Geometrical approach, J. Geophys. Res., 84, 3615-3622, 1979.

Gazdag, J., Wave equation migration with the accurate space derivative method, Geophys. Prosp.,

Gazdag, J., Modeling of the acoustic wave equation with transform methods, Geophys., 46, 854-859, 1981.

Geller, R. J., G. A. Frazier and M. W. McCann, Jr., Dynamic finite element modeling of dislocations in a laterally hererogeneous crust, J. Phys. Earth, 27, 395-407, 1979.

Geller, R. J., and S. Stein, Time-domain attenuation measurements for fundamental spheroidal modes (0S6 to 0S28) for the 1977 Indonesian earthquake, Bull. Seis. Soc. Am., 69, 1671-1691, 1979.

Gettrust, J. F., and L. N. Frazer, A computer model study of the propagation of long-range Pn phase, Geophys. Res. Lett., 8, 749-752, 1981.

Gibson, B. S., M. E. Odegard, and G. H. Sutton, Nonlinear least-squares inversion of traveltime data for a linear velocity-depth relationship, Geophys., 44, 185-194, 1979.

Gilbert, F., An introduction to low-frequency seismology, Physics of the Earth's Interior, Course LXXVIII, A. Dziewonski and E. Boschi, eds., North Holland Publ. Co., New York, 41-81, 1980.

Gilbert, F., and G. E. Backus, Propagator

matrices in elastic wave and vibration problems, Geophys., 31, 326-332, 1966.
Gilmlin, D. R., and J. W. Smith, A comparison of seismic trace summing techniques, Geophys., 45, 1017-1041, 1980.
Godfrey, R., F. Muir, and F. Rocca, Modeling seismic impedance with Markov chains, Geophys., 45, 1351-1371, 1980.
Godfrey, R., and F. Rocca, Zero memory non-linear deconvolution, Geophys. Prosp., 29, 189-228, 1981.
Goforth, T., and E. Herrin, Phase-matched filters: Application to the study of Love waves, Bull. Seism. Soc. Am., 69, 27-44, 1979.
Goforth, T., and E. Herrin, An automatic seismic signal detection algorithm based on the Walsh transform, Bull. Seism. Soc. Am., 71, 1351-1360, 1981.
Hald, O. H., Inverse eigenvalue problems for the mantle, Geophys. J. R. astr. Soc., 62, 41-48, 1980.
Hanks, T. C., b -values and $\omega^{-\gamma}$ seismic source models: Implications for tectonic stress variations along active crustal fault zones and the estimation of high-frequency strong ground motions, J. Geophys. Res., 84, 2235-2242, 1979.
Hanks, T. C., The corner frequency shift, earthquake source models and Q, Bull. Seism. Soc. Am., 71, 597-612, 1981.
Hansen, R. A., Simultaneous estimation of terrestrial eigenvibrations, Geophys. J. R. astr. Soc., 70, 155-172, 1982.
Harkrider, D. G., Coupling near source phenomena into surface wave generation, Identification of Seismic Sources - Earthquake or Underground Explosion, E. S. Huseby and S. Mykkeltveit, eds., D. Reidel Publ. Co., Boston, 277-326, 1981.
Harmsen, S., and S. Harding, Surface motion over a sedimentary valley for incident plane P and SV waves Bull. Seism. Soc. Am., 71, 655-670. 1981.
Harris, J. G., and J. D. Achenbach, Near-field surface motions excited by radiation from a slip zone of arbitrary shape, J. Geophys. Res., 86, 9352-9356, 1981.
Hartzell, S., Analysis of the Bucharest strong ground motion record for the March 4, 1977 Romanian earthquake, Bull. Seism. Soc. Am., 69, 513-530, 1979.
Hartzell, S. H., and J. N. Brune, The Horse Canyon earthquake of August 2, 1975 - Two -stage stress-release process in a strike-slip earthquake, Bull. Seism. Soc. Am., 69, 1161-1174, 1979.
Hartzell, S., Faulting process of the May 17, 1976 Gazli, USSR earthquake, Bull. Seism. Soc. Am., 70, 1715-1736, 1980.
Harvey, D. J., Seismogram synthesis using normal mode superposition: the locked mode approximation, Geophys. J. R. astr. Soc., 66, 37-69, 1981.
Hatton, L., K. Larner, and B. S. Gibson, Migration of seismic data from inhomogeneous media, Geophys., 46, 751-767, 1981.
Hauge, P. S., Measurements of attenuation from vertical seismic profiles, Geophys., 46, 1548-1558, 1981.
Heaton, T. H., and D. V. Helmberger, Generalized ray models of the San Fernando earthquake, Bull. Seism. Soc. Am., 69, 1311-1341, 1979.
Heaton, T. H., The 1971 San Fernando earthquake: A double event? Bull. Seism. Soc. Am., 1972, 2037-2062, 1982.
Helmberger, D. V., and L. J. Burdick, Synthetic seismograms, Annual Reveiw of Earth and Planetary Sciences, 7, G. W. Wetherill, A. L. Albee, and F. G. Stehl, eds., Annual Reviews Inc., Palo Alto, 417-442, 1979.
Helmberger, D. V., and G. R. Engen, Modeling the long-period body waves from shallow earthquakes at regional ranges, Bull. Seism. Soc. Am., 70, 1699-1714, 1980.
Henry, M., J. A. Orcutt, and R. L. Parker, A new method for slant stacking refraction data, Geophys. Res. Lett., 7, 1073-1076, 1980.
Henstridge, J. D., A signal processing method for circular arrays, Geophys., 44, 179-184, 1979.
Henyey, H. S., and N. Pomphrey, Self-consistent elastic moduli of a cracked solid, Geophys. Res. Lett., 9, 903-906, 1982.
Herman, A. J., R. M. Anania, J. H. Chun, C. A. Jacewitz and R. E. F. Pepper, A fast three-dimensional modeling technique and fundamentals of three-dimensional frequency-domain migration, Geophys., 47, 1627-1644, 21982.
Herrmann, R. B., SH-wave generation by dislocation sources - a numerical study, Bull. Seism. Soc. Am., 69, 1-15, 1979.
Herrmann, R. B., Q estimates using the coda of local earthquakes, Bull. Seism. Soc. Am., 70, 447-468, 1980.
Herrmann, R. B., J. W. Dewey, and S. K. Park, The Dulce, New Mexico, earthquake of 23 January 1966, Bull. Seism. Soc. Am., 70, 2171-2183, 1980.
Heusinkveld, M., Analysis of shock wave arrival time from underground explosions, J. Geophys. Res., 87, 1891-1898, 1982.
Hildebrand, S. T., Linear prediction error filter design, Geophys., 46, 875-879, 1981.
Hileman, J. A., Inversion of phase times for hypocenters and shallow crustal velocities, Mojave Desert, California, Bull. Seism. Soc. Am., 69, 387-396, 1979.
Hilterman, F. J., Interpretative lessons from three-dimensional modeling, Geophys., 47, 784-808, 1982.
Hubral, P., Wavefront curvatures in three-dimensonal laterally inhomogeneous media with curved interfaces, Geophys., 45, 905-913, 1980.
Hubral, P., S. Treitel and P. R. Gutowski, A sum autoregressive formula for the reflection response, Geophys., 45, 1697-1705, 1980.
Hudson, J. A., D. M. Boore, Comments on 'Scattered surface waves from a surface obstacle' by J. A. Hudson, Geophys. J. R. astr. Soc., 60, 123-127, 1980.
Inguva, R., and L. H. Schick, Information theoretic proccessing of seismic data, Geophys. Res. Lett., 8, 1199-1202, 1981.
Israel, M., and A. Nur, A complete solution of a one-dimensional propagating fault with nonuniform stress and strength, J. Geophys. Res., 84, 2223-2234, 1979.
Jackson, D. D., The use of a priori data to resolve non-uniqueness in linear inversion, Geophys. J. R. astr. Soc., 57, 137-157, 1979.
Jensen, O. G., Seismic detection of gravitational radiation, Rev. Geophys. Space Phys., 17, 2057-2069, 1979.
Jennings, P. C., and H. Kanamori, Determination of local magnitude, M_L , from seismoscope records, Bull. Seism. Soc. Am., 69, 1267-1288, 1979.
Jin, D. J., and E. Herrin, Surface wave studies of the Bering Sea and Alaska area, Bull. Seism. Soc. Am., 70, 2117-2144, 1980.
Johnson, D. H., M. N. Toksoz, and A. Timur, Attenuation of seismic waves in dry and saturated rocks: II. Mechanisms, Geophys., 44, 691-711, 1979.
Jordan, T. H., Earth structures from seismological observations, Physics of the Earth's Interior, Course LXXVIII, A. Dziewonski and E. Boschi, eds., North Holland Publ. Co., New York, 1-40, 1980.
Jordan, T., H., and K. A. Sverdrup, Teleseismic location techniques and their application to earthquake clusters in the south-central Pacific, Bull. Seism. Soc. Am., 71, 1105-1130, 1981.
Jurkevics, A., and R. Wiggins, Body-wave inversion using travel time and amplitude data, Geophys. J. R. astr. Soc., 63, 75-93, 1980.
Kagan, Y. Y., Spatial distribution of earthquakes: the three-point moment function, Geophys. J. R. astr. Soc., 67, 697- 717, 1981.
Kagan, Y. Y., Spatial distribution of earthquakes: the four-point moment function, Geophys. J. R. astr. Soc., 67, 719-733, 1981.
Kagan, Y. Y., Stochastic model of earthquake fault geometry, Geophys. J. R. astr. Soc., 71, 659-691, 1982.
Kamel, A., and L. B. Felsen, Hybrid ray-mode formulation of SH motion in a two-layer half-space, Bull. Seism. Soc. Am., 71, 1763-1781, 1981.
Kanamori, H., A semi-empirical approach to prediction of long period ground motions from great earthquakes, Bull. Seism. Soc. Am., 69, 1645-1670, 1979.
Kanamori, H., and J. W. Given, Analysis of long-period seismic waves excited by the May 18, 1980, eruption of Mount St. Helens - A terrestrial monopole?, J. Geophys. Res., 87, 5422-5432, 1982.
Kanamori, H., and J. W. Given, Use of long-period surface waves for rapid determination of earthquake-source parameters, Phys. Earth Planet. Inter., 27, 8-31, 1981.
Kanamori, H., and J. W. Given, Use of Long-period surface waves for rapid determination of earthquake source parameters, 2. Preliminary determination of source mechanisms of large earthquakes (M_S> 6.5) in 1980, Phys. Earth and Planet. Int., 30, 260-268, 1982.
Kaufman, K., and L. J. Burdick, The reproducing earthquakes of the Galapagos Islands, Bull. Seism. Soc. Am., 70, 1759-1770, 1980.
Kausel, E., and R. Peek, Dynamic loads in the interior of a layered stratum: An explicit solution, Bull. Seism. Soc. Am., 72, 1459-1481, 1982.
Kausel, E., and J. M. Roesset, Stiffness matrices for layered soils, Bull. Seism. Soc. Am., 71, 1743-1761, 1981.
Kausel, E., and J. L. Tassoulas, Transmitting boundaries: A closed-form comparison, Bull. Seism. Soc. Am., 71, 143-159, 1981.
Kawakatsu, H., and R. J. Geller, A new iterative method for finding the normal modes of a laterally heterogeneous body, Geophys. Res. Lett., 8, 1195-1197, 1981.
Kawasaki, I., and T. Tanimoto, Radiaton patterns of body waves due to the seismic dislocation occurring in an anisotropic source medium, Bull. Seism. Soc. Am., 71, 37-50, 1981.
Kawasaki, I., A method for the near-source anisotropy by the pair-event inversion ofRayleigh-wave radiation patterns, Geophys. J. R. astr. Soc., 71, 395-424, 1982.
Keer, L. M., and S. H. Chen, The intersection of a pressurized crack with a joint, J. Geophys. Res., 86, 1032-1038, 1981.
Kempner, W. C., and J. F. Gettrust, Ophiolites, synthetic seismograms, and ocean crustal structure. 1. Comparison of ocean bottom seismometer data and synthetic seismograms for the Bay of Islands ophiolite, J. Geophys. Res., 87, 8447-8462, 1982.
Kempner, W. C., and J. F. Gettrust, Ophiolites, synthetic seismograms, and oceanic crustal structure. 2. A comparison of synthetic seismograms of the samail ophiolite, Oman, and the ROSE refraction data from the East Pacific Rise, J. Geophys. Res., 87, 8463-8476, 1982.
Kikuchi, M., Dispersion and attenuation of elastic waves due to multiple scattering from cracks, Phys. Earth Planet. Inter., 27, 100-105, 1981.
Kikuchi, M., Dispersion and attenuation of elastic waves due to multiple scattering from inclusions, Phys. Earth Planet. Inter., 25, 159-162, 1981.
Kikuchi, M., and H. Kanamori, Inversion of complex body waves, Bull. Seism. Soc. Am., 72, 491-506, 1982.
Kisslinger, C., Evaluation of S to P amplitude ratios for determining focal mechanisms from regional network observations, Bull. Seism. Soc. Am., 70, 999-1014, 1980.
Kjartansson, E., Constant Q-wave propagation and attenuation, J. Geophys. Res., 84, 4737-4748, 1979.
Knopoff, L., A matrix method for elastic wave problems, Bull. Seism. Soc. Am., 54, 431-438, 1964.
Knopoff, L., The nature of the earthquake source, Identification of Seismic Sources - Earthquake or Underground Explosion, E. S. Huseby and S. Mykkeltveit, eds., D. Reidel Publ. Co., Boston, 49-69, 1981.
Knopoff, L., and A. K. Chatterjee, Unilateral extension of a two-dimensional shear crack under the influence of cohesive forces, Geophys. J. astr. Soc., 68, 7-25, 1982.
Kosloff, D. D., and E. Baysal, Forward modeling by a Fourier method, Geophys., 47, 1402-1412, 1982.
Kostrov, B. V., and S. Das., Idealized models of fault behavior prior to dynamic rupture, Bull. Seism. Soc. Am., 72, 679-703, 1982.
Krebes, E. S., and F. Hron, Synthetic seismograms for SH waves in a layered anelastic medium by asymptotic ray theory, Bull. Seism. Soc. Am., 70, 2005-2020, 1980.
Krebes, E. S., and F. Hron, Comparison of synthetic seismograms for anelastic media by asymptotic ray theory and Thomson-Haskell method, Bull. Seism. Soc. Am., 71, 1463-1468, 1981.
Krey, T., H. Arnetzl, and M. Knecht, Theoretical and practical aspects of absorption in the application of in-seam seismic coal exploration, Geophys., 47, 1645-1656, 1982.
Kristy, M. J., L. J. Burdick, and D. W. Simpson, The focal mechanisms of the Gazli, USSR, earthquakes, Bull. Seism. Soc. Am., 70, 1737-1750. 1980.
Kummer, B., and A. Behle, Second-order finite-difference modeling of SH-wave propagation in laterally inhomogeneous media, Bull. Seism. Soc. Am., 72, 793-808, 1982.
Landoni, J. A. and L. Knopoff, Dynamics of a one-dimensional crack with variable friction, Geophys. J. R. astr. Soc., 64, 151-161, 1981.
Langston, C. A., A note on spectral nulls in Rayleigh waves, Bull. Seism. Soc. Am., 70, 1409-1414, 1980.
Langston, C. A., Source inversion of seismic waveforms: The Koyna, India, earthquake of 14 September 1967, Bull. Seism. Soc. Am., 71, 1-24, 1981.
Langston, C. A., J. S. Barker and G. B. Pavlin, Point-source inversion techniques, Phys. Earth and Planet. Int., 228-241, 1982.
Larner, K. L., Hatton, L., B. S. Gibson, and I-Chi Hsu, Depth migration of imaged time sections, Geophys., 46, 734-750, 1981.
Larson, D. B., Inelastic wave propagation in sodium chloride, Bull. Seism. Soc. Am., 72, 2107-2120, 1982.
Leary, P. C., and P. E. Malin, Millisecond accurate monitoring of seismic travel times over 13- and 18-kilometer baselines, J. Geophys. Res., 87, 6919-6930, 1982.
Lee, M. W., and A. H. Balch, Theoretical seismic wave radiation from a fluid-filled borehole, Geophys., 47, 1308-1314, 1982.
Levin, F. K., Seismic velocities in transversely isotropic media, Geophys., 44, 918-936, 1979.
Lin, I., and C. C. Tung, A preliminary investigation of Tsunami hazard, Bull. Seism. Soc. Am., 72, 2323-2337, 1982.
Lines, L. R., R. W. Clayton, and T. J.

Ulrich, Impulse response models for noisy vibroseis data, Geophys. Prosp., 28, 49-59, 1980.

List, R. D., The solution of the dynamic field of the Haskell fault model reconsidered, Bull. Seism. Soc. Am., 72, 1069-1083, 1982.

Little, R. R., and D. D. Raftopoulos, Vertical soil-structure interaction effects, Bull. Seism. Soc. Am., 69, 221-236, 1979.

Liu, H.-P., and D. D. Kosloff, Numerical evaluation of the Hilbert transform by the fast Fourier transform (FFT) technique, Geophys. J. R. astr. Soc., 67, 791-799, 1981.

Liu, H.-S., Convection-generated stress concentration and seismogenic model of the Tangshan earthquake, Phys. Earth Planet. Inter., 19, 307-318, 1979.

Liu, H. L., and H. Kanamori, Determination of source parameters of mid-plate earthquakes from the waveforms of body waves, Bull. Seism. Soc. Am., 70, 1989-2004, 1980.

Lomnitz-Adler, J., and C. Lomnitz, A modified form of the Gutenberg-Richter magnitude-frequency relation, Bull. Seism. Soc. Am., 69, 1209-1214, 1979.

Luco, J. E., Lower bounds for peak horizontal strong-motion amplitudes, Bull. Seism. Soc. Am., 70, 1309-1320, 1980.

Luco, J. E., and D. A. Sotiropoulos, Local characterization of free-field ground motion and effects of wave passage, Bull. Seism. Soc. Am., 70, 2229-2244, 1980.

Lynn, W. S., and J. F. Claerbout, Velocity estimation in laterally varying media, Geophys., 47, 884-897, 1982.

MacKenzie, K., J. McClain, and J. Orcutt, Constraints on crustal structure in eastern Iceland based on extremal inversions of refraction data, J. Geophys. Res., 87, 6371-6382, 1982.

Madariaga, R., On the relation between seismic moment and stress drop in the presence of stress and strength heterogeneity, J. Geophys. Res., 84, 2243-2250, 1979.

Mahrer, K. D., and A. Nur, Static strike-slip faulting in a horizontally varying crust, Bull. Seism. Soc. Am., 69, 975-1009, 1979.

Mahrer, K. D., and A. Nur, Strike slip faulting in a downward varying crust, J. Geophys. Res., 84, 2296-2302, 1979.

Makjanic, B., On the generalized exponential distribution of earthquake intensity and magnitude, Bull. Seism. Soc. Am., 72, 981-986, 1982.

Malin, P. E., A first-order scattering solution for modelling elastic wave codas - I. The acoustic case, Geophys. J. R. astr. Soc., 63, 361-380, 1980.

Marple, S. L., Jr., Frequency resolution of Fourier and maximum entropy spectral estimates, Geophys., 47, 1303-1307, 1982.

Marfinson, D. G., W. Menke, and P. Stoffa, An inverse approach to signal correlation, J. Geophys. Res., 87, 4807-4818, 1982.

Masse, R. P., Review of seismic source models for underground explosions, Bull. Seism. Soc. Am., 71, 1249-1268, 1981.

Mavko, G. M., Frictional attenuation: An inherent amplitude dependence, J. Geophys. Res., 84, 4769-4775, 1979.

Mavko, G. M., Velocity and attenuation in partially molten rocks, J. Geophys. Res., 85, 5173-5189, 1980.

Mavko, G. M., Easy computation of static stress drop, slip, and moment on two-dimensional heterogeneous faults, Bull. Seism. Soc. Am., 72, 1499-1508, 1982.

Mavko, G. M., Mechanics of motion on major faults, Annual Reveiw of Earth and Planetary Sciences, 9, G. W. Wetherill, A. L. Albee, and F. G. Stehl, eds., Annual Reviews Inc., Palo Alto, 81-111, 1981.

Mavko, G. M., and A. Nur, Wave attenuation in partially saturated rocks, Geophys., 44, 161-178, 1979.

May, B. T., and J. D. Covey, An inverse method for computing geologic structures from seismic reflections - Zero-offset case, Geophys., 46, 268-287, 1981.

May, B. T., and D. K. Straley, Higher-order moveout spectra, Geophys., 44, 1193-1207, 1979.

McCoy, J. J., Parabolic wave theories and some recent applications, Phys. Earth Planet. Inter., 21, 126-133, 1980.

McGarr, A., Analysis of peak ground motion in terms of a model of inhomogeneous faulting, J. Geophys. Res., 86, 3901-3912, 1981.

McGarr, A., Analysis of states of stress between provinces of constant stress, J. Geophys. Res., 87, 929-9288, 1982.

McGarr, A., Upper bounds on near-source peak ground motion based on a model of inhomogeneous faulting, Bull Seism. Soc. Am., 72, 1825-1841, 1982.

McGuire, R. K., and T. C. Hanks, RMS accelerations and spectral amplitudes of strong ground motion during the San Fernando, California earthquake, Bull. Seism. Soc. Am., 70, 1980.

McMechan, G. A., Resonant scattering of fluid-filled cavities, Bull. Seism. Soc. Am., 72, 1143-1153, 1982.

McMechan, G. A., R. W. Clayton, and W. D. Mooney, Application of wave field continuation to the inversion of refraction data, J. Geophys. Res., 87, 927-935, 1982.

McMechan, G. A., and W. D. Mooney, Asymptotic ray theory and synthetic seismograms for laterally varying structures: theory and application to the Imperial Valley, California Bull. Seism. Soc. Am., 70, 2021-2035, 1980.

McMechan, G. A., and R. Ortolini, Direct observation of a p- curve in a slant stacked wave field, Bull. Seism. Soc. Am., 70, 775-789, 1980.

McMechan, G. A., and M. Yedlin, Analysis of dispersive waves by wave field transformation, Geophys., 46, 869-874, 1981.

Mei, C. C. and M. A. Foda, Wave-induced responses in a fluid-filled poro-elastic solid with a free surface - a boundary layer theory, Geophys. J. R. astr. Soc., 66, 597-631, 1981.

Mellman, G. R., A method of body-wave waveform inversion for the determination of earth structure, Geophys. J. R. astr. Soc., 62, 481-504, 1980.

Melosh, H. J., and A. Raefsky, A simple and efficient method for introducing faults into finite element computations, Bull. Seism. Soc. Am., 71, 1391-1400, 1981.

Melosh, H. J., and L. Fleitout, The earthquake cycle in subduction zones, Geophys. Res. Lett., 9, 21-24, 1982.

Mendel, J. M., Generalized Kunetz-type equations, Geophys. Prosp., 28, 240-256, 1980.

Mendel, J. M., A time domain approach to the normal-incidence inverse problem, Geophys. Prosp., 29, 742-757, 1981.

Mendel, J. M., J. Kormylo, F. Aminzadeh, J. S. Lee, and F. Habibi-Ashrafi, A novel approach to seismic signal processing and modeling, Geophys., 46, 1398-1414, 1981.

Mendel, J. M., N. E. Nahi, and M. Chan, Synthetic seismograms using the state-space approach, Geophys., 44, 880-895, 1979.

Menke, W., Comment on 'Dispersion function computations for unlimited frequency values' by Anas Abo-Zeno, Geophys. J. R. astr. Soc., 59, 325-323, 1979.

Menke, W., The effect of load shape on the deflection of thin elastic plates, Geophys. J. R. astr. Soc., 65, 571-577, 1981.

Menke, W., On extending Biot's theory of multiple scattering at low frequencies from acoustic to elastic media, Geophys. J. R. astr. Soc., 69, 819-830, 1982.

Menke W. H., and Richards, P. G., Crust-mantle whispering gallery phases: A deterministic model of teleseismic P_n wave propagation, J. Geophys Res., 85, 5426-5422, 1980.

Miller, R. K., An estimate of the properties of Love-type surface waves in a frictionally bonded layer, Bull. Seism. Soc. Am., 69, 305-317, 1979.

Minster, J. B., Near-field waveforms from an arbitrarily expanding transparent spherical cavity in a prestressed medium, Geophys. J. R. astr. Soc., 56, 81-96, 1979.

Minster, J. B., Anelasticity and attenuation, Physics of the Earth's Interior, Course LXXVIII, A. Dziewonski and E. Boschi, eds., North Holland Publ. Co., New York, 152-212, 1980.

Minster, J. B., and D. L. Anderson, Dislocations and nonelastic processes in the mantle, J. Geophys. Res., 85, 6347-6352, 1981.

Minster, J. B., and D. L. Anderson, A model of dislocation-controlled rheology for the mantle, Phil. Trans. Roy. Soc. London, 299, 319-356, 1981.

Mitchel, R. G., and R. B. Herrman, Shear velocity structure in the eastern United States from thee inversion of surface-wave group and phase velocities, Bull. Seism. Soc. Am., 69, 1133-1148, 1979.

Mitchel, R. G., Array measurements of higher mode Rayleigh wave dispersion: an approach utilizing source parameters, Geophys. J. R. astr. Soc., 63, 311-331, 1980.

Mochizuki, S., Attenuation in partially saturated rocks, J. Geophys. Res., 87, 8598-8604, 1982.

Molnar, P., Earthquake recurrence intervals and plate tectonics, Bull. Seism. Soc. Am., 69,115-133, 1979.

Mooney, W. D., R. P. Meyer, J. P. Laurence, H. Meyer, and J. Emilio Ramirez, Seismic refraction studies of the western Cordillera, Colombia, Bull. Seism. Soc. Am., 69, 1745-1761, 1979.

Morris, S. P., and R. J. Geller, A variational calculation of the toroidal modes of a simple laterally heterogeneous model, Bull. Seism. Soc. Am., 72, 1155-1166, 1982.

Mortgat, C. P., and H. Shah, A Bayesian model for seismic hazard mapping, Bull. Seism. Soc. Am., 69, 1237-1251, 1979.

Murphy, J. R., Near-field Rayleigh waves from surface explosions, Bull. Seism. Soc. Am., 71, 223-248, 1981.

Nakanishi, I., and H. Kanamori, Effects of lateral heterogeneity and source process time on the linear moment tensor inversion of long-period Rayleigh waves, Bull. Seism. Soc. Am., 72, 2063-2080, 1982.

Newman, W. I., and L. Knopoff, Crack fusion dynamics: a model for large earthquakes, Geophys. Res. Lett., 9, 735-738, 1982.

Newton, R. G., Inversion of reflection data for layered media: a review of exact methods, Geophys. J. R. astr. Soc., 65, 191-215, 1981.

Newton, R. G., Note on inversion of reflection data for layered media, Geophys. J. R. astr. Soc., 69, 571-572, 1982.

Niazi, M., and H. Kanamori, Source parameters of 1978 Tabas and 1979 Qainat, Iran, earthquakes from long-period surface waves, Bull. Seism. Soc. Am., 71, 1201-1213, 1981.

Niazy, A., and M. H. Kazi, On the effect of the higher modes on the scattering of Love waves at the boundary of welded layered quarter-spaces, Bull. Seism. Soc. Am., 72, 29-53, 1982.

Nicolas, M., B. Massinon, P. Mechler and M. Bouchon, Attenuation of regional phases in western Europe, Bull. Seism. Soc. Am., 72, 2089-2106, 1982.

Nivers, E., S. H. Chao, and L. B. Felsen, Rays and modes in an acoustic channel with exponential velocity profile, Radio Sci., 16(6), Nov.-Dec., 1981.

Nur, A., Seismic velocities in low porosity rocks, Source Mechanism and Earthquake Prediction, C. J. Allegre, ed., CNRS, Paris, 71-98, 1980.

Nur, A., and M. Israel, The role heterogeneities in faulting, Phys. Earth Planet. Inter., 21, 225-236, 1980.

O'Brien, J. T., W. P. Kamp, and G. M. Hoover, Sign-bit amplitude recovery with applications to seismic data, Geophys., 47, 1527-1539, 1982.

O'Neill, M. E., and D. P. Hill, Causal absorption: Its effect on synthetic seismograms computed by the reflectivity method, Bull. Seism. Soc. Am., 69, 17-25, 1979.

Okal, E. A., Higher moment excitation of normal modes and surface waves, J. Phys. Earth., 30, 1-32, 1982.

Okal, E. A., Mode-wave equivalence and other asymptotic problems in tsunami theory, Phys. Earth Planet. Inter., 30, 1-11, 1982.

Okal, E. A., and R. J. Geller, On the observability of isotropic seismic sources: The July 31, 1970 Columbian Earthquake, Phys. Earth Planet. Inter., 18, 176-196, 1979.

Okal, E. A., and R. J. Geller, Shear-wave velocity at the base of the mantle from profiles of diffracted SH waves, Bull. Seism. Soc. Am., 69, 1039-1053, 1979.

Olsen, K. H., and L. W. Braile, Seismograms of explosions at regional distances in the western united states: observations and reflectivity method modeling, Identification of Seismic Sources - Earthquake or Underground Explosion, E. S. Huseby and S. Mykkeltveit, eds., D. Reidel Publ. Co., Boston, 453-466, 1981.

Olson, A. H., Forward simulation and linear inversion of earthquake ground motions, Ph.D. Dissertaion, Earth Science, University of California, San Diego, 1982.

Olson, A. H., and R. J. Apsel, Finite faults and inverse theory with applications to the 1979 Imperial Valley earthquake, Bull. Seism. Soc. Am., 72, 1969-2001, 1982.

Orcutt, J. A., Joint linear, external inversion of seismic kinematic data, J. Geophys. Res., 85, 2649-2660, 1980.

Orcutt, J. A., K. MacKenzie, and J. McClain, The role of X(p) constraints in linear extremal inversion of explosion profile data, Bull. Seism. Soc. Am., 70, 2103-2116, 1980.

Pann, K., Y. Shin, and E. Eisner, A collocation formulation of wave equation migraton, Geophys., 44, 712-721, 1979.

Pao, Y.-H., and F. Ziegler, Transient SH-waves in wedge-shaped layer, Geophys. J. R. astr. Soc.,

Pare, M. E., and H. C. Shah, Public policy issues: Earthquake prediction, Bull. Seism. Soc. Am., 69, 1533-1547, 1979.

Pare, M. E., and H. C. Shah, Public policy issues: Earthquake engineering, Bull. Seism. Soc. Am., 70, 1955-1968, 1980.

Patton, H., Reference point equalization method for determining the source and path effects of surface waves, J. Geophys. Res., 85, 821-848, 1980.

Patton, H., and K. Aki, Bias in the estimate of seismic moment tensor by the linear inverson method, Geophys. J., R. astr. Soc., 59, 479-495, 1979.

Patwardhan, A. S., R. B. Kulkarni, and D. Tocher, A semi-markov model for characterizing recurrence of great earthquakes, Bull. Seism. Soc. Am., 70, 323-347, 1980.

Pavlis, G. L., and J. R. Booker, The mixed discrete-continuous inverse problem: Application to the simultaneous determination of earthquake hypocenters and velocity structure, J. Geophys. Res., 85, 4801-4810, 1980.

Peacock, K. L., Discrete operators for integation, Geophys., 44, 722-729, 1979.

Pechmann, J. C., and H. Kanamori, Waveforms and spectra of preshocks and aftershocks of the 1979 Imperial Valley, California, earthquake: Evidence for fault heterogeneity? J. Geophys. Res., 87, 10,579-10,597, 1982.

Pereya, V., H. B. Keller, and W. H. K. Lee,

Computational methods for inverse problems in geophysics: inversion of travel time observations, Phys. Earth Planet. Inter., 21, 120-125, 1980.
Pereyra, V., W. H. K. Lee, and H. B. Keller, Solving two-point seismic-ray tracing problems in a heterogeneous medium, Bull. Seism. Soc. Am., 70, 79-99, 1980.
Pilant, W. L., Elastic Waves in the Earth, Elsevier Sci. Publ. Co., New York, 493 pp., 1979.
Porter, L. D., F. Schwab, K. K. Nakanishi, I. F. Weeks, G. F. Panza, E. Mantovani, D. McMenamin, W. D. Smythe, A. H. Liao, J. A. Landoni, N. N. Biswas, F.-S. Chang, S. S. Bor, E. G. Kausel, P. Gasperini, and J. L. Luthey, Relative computer speeds for surface-wave disperson computations, Bull. Seism. Soc. Am., 70, 1415-1420, 1980.
Priestley, K., J. A. Orcutt, and J. N. Brune, Higher-mode surface waves and structure of the Great Basin of Nevada and western Utah, J. Geophys. Res., 85, 7166-7174, 1980.
Radovich, B. J., and F. K. Levin, Instantaneous velocities and reflection times for transversely isotropic solids, Geophys., 47, 316-322, 1982.
Raz, S., Direct reconstruction of velocity and density profiles from scattered field data, Geophys., 46, 832-836, 1981.
Raz, S., Three-dimensional velocity profile inversion from finite- offset scattering data, Geophys., 46, 837-842, 1981.
Rial, J. A., and V. F. Cormier, Seismic waves at the epicenter's antipode, J. Geophys. Res., 85, 2661-2668, 1980.
Rice, J. R., The mechanics of earthquake rupture, Physics of the Earth's Interior, Course LXXVIII, A. Dziewonski and E. Boschi, eds., North Holland Publ. Co., New York, 555-649, 1980.
Rice, J. R., and J. W. Rudnicki, Earthquake precursory effects due to pore fluid stabilization of a weakening fault zone, J. Geophys. Res., 84, 2177-2193, 1979.
Richards, P. G., Elementary solutions to Lamb's problem for a point source and their relevance to three-dimensonal studies of spontaneous crack propagaton, Bull. Seism. Soc. Am., 69, 947-956, 1979.
Riedesel, M. A., D. Agnew, J. Berger, and F. Gilbert, Stacking for the frequencies and Q s of gSo 1So ,Geophys. J. R. astr. Soc., 62, 457-471, 1980.
Rietsch, E., Estimation of the signal-to-noise ratio of seismic data with an application to stacking, Geophys. Prosp., 28, 531-550, 1980.
Rietsch, E., Reduction of harmonic distortion in vibratory source records, Geophys. Prosp., 29, 178-188, 1981.
Robinson, J. C., A technique for the continuous representation of dispersion data, Geophys., 44, 1345-1351, 1979.
Rodean, H. C., Inelastic processes in seismic wave generation by underground explosions, Identification of Seismic Sources - Earthquake or Underground Explosion, E. S. Huseby and S. Mykkeltveit, eds., D. Reidel Publ. Co., Boston, 97-189, 1981.
Romanowicz, B., Constraints on the structure of the Tibet plateau from pure path phase velocities of Love and Rayleigh waves, J. Geophys. Res., 87, 6865-6883, 1982.
Romanowicz, B. A., Moment tensor inverson of long period Rayleigh waves: A new approach, J. Geophys. Res., 87, 5395-5407, 1982.
Rosenbaum, J. H., and G. F. Boudreaux, Rapid convergence of some seismic processing algorithms, Geophys., 46, 1667-1672, 1981.
Rudnicki, J. W., Rotation of principal stress axes caused by faulting, Geophys. Res. Lett., 6, 135-138, 1979.
Rudnicki, J. W., The stabilization of slip on a narrow weakening fault zone by coupled deformation-pore fluid diffusion, Bull. Seism. Soc. Am., 69, 1011-1026, 1979.
Rudnicki, J. W., Fracture mechanics applied to the earth's crust, Annual Reveiw of Earth and Planetary Sciences, 8, G. W. Wetherill, A. L. Albee, and F. G. Stehl, eds., Annual Reviews Inc., Palo Alto, 489-525, 1980.
Rudnicki, J. W., and L. B. Freund, On energy radiation from seismic sources, Bull. Seism. Soc. Am., 71, 583-595, 1981.
Rudnicki, J. W., and H. Kanamori, Effects of fault interaction on moment, stress drop, and strain energy release, J. Geophys. Res., 86, 1785-1793, 1981.
Rundle, J. B., Static elastic-gravitational deformation of a layered half space by point couple sources, J. Geophys. Res., 85, 5355-5363, 1980.
Rundle, J. B., Vertical displacements from a rectangular fault in layered elastic-gravitational media, J. Phys. Earth, 29, 173-186, 1981.
Ru-Shan, W., Attenuation of short period seismic waves due to scattering, Geophys. Res. Lett., 9, 9-13, 1982.
Salvado, C., and J. B. Minster, Slipping interfaces: A possible source of S radiation from explosive sources, Bull. Seism. Soc. Am., 70, 659-670, 1980.
Sanchez-Sesma, F. J., I. Herrera, and J. Aviles, A boundary method for elastic wave diffraction: Application to scattering of SH waves by surface irregularities, Bull. Seism. Soc. Am., 72, 473-490, 1982.
Santosa, F., Numerical scheme for the inversion of acoustical impedance profile based on the Gelfand-Levitan method, Geophys. J. R. astr. Soc., 70, 22-243, 1982.
Saro, H., Coda wave excitation due to nonisotropic scattering and nonspherical source radiation, J. Geophys. Res., 87, 8665-8674, 1982.
Schlue, J. W., Love-wave propagation in three-dimensional structures using finite element techniques, Bull. Seism. Soc. Am., 69, 319-328, 1979.
Schlue, J. W., Finite element matrices for seismic surface waves in three-dimensonal structures, Bull. Seism. Soc. Am., 69, 1425-1437, 1979.
Schlue, J. W., Seismic surface wave propagation in three-dimensional finite-element structures, Bull. Seism. Soc. Am., 71, 1003-1010, 1981.
Scholz, C. H., Scaling relations for strong ground motion in large earthquakes, Bull. Seism. Soc. Am., 72, 1903-1909, 1982.
Schultz, P. S., A method for direct estimation of interval velocities, Geophys., 12, 1657-1671, 1982.
Schwab, F., J. Frez, G. F. Panza, A. H. Liao, and E. G. Kausel, Surface-wave dispersion computations: Rayleigh waves on a spherical gravirating earth, Bull. Seism. Soc. Am., 71, 613-654, 1981.
Segall, P., and D. D. Pollard, Mechanics of discontinuous faults, J. Geophys. Res., 85, 4337-4350, 1980.
Shi, Y., and B. A. Bolt, The standard error of the magnitude- frequency b value, Bull. Seism. Soc. Am., 72, 1677-1687, 1982.
Shimazaki, K., and P. Somerville, Static and dynamic parameters of the Izu-Oshima, Japan earthquake of January 14, 1978, Bull. Seism. Soc. Am., 69, 1343-1378, 1979.
Silver, P. G., and T. H. Jordan, Fundamental spheroidal mode observations of aspherical heterogeneity, Geophys. J. R. astr. Soc., 64, 605-634, 1981.
Silver, P. G., and T. H. Jordan, Optimal estimation of scaler seismic moment, Geophy. J. R. astr. Soc., 70, 755-788, 1982.
Singh, S. K., R. J. Apsel, J. Fried and J. N. Brune, Spectral attenuaton of SH waves along the Imperial Fault, Bull. Seism. Soc. Am., 72, 2003-2016, 1982.
Sinton, J. B., and L. N. Frazer, A method for the computation of finite frequency body wave synthetic seismograms in laterally varying media, Geophys. J. R. astr. Soc., 71, 37-56, 1982.
Sipkin, S. A., and T. H. Jordan, Frequency dependence of Q_{SCS}, Bull. Seism. Soc. Am., 69, 1055-1079, 1979.
Sipkin, S. A., Estimaton of earthquake source parameters by the inversion of waveform data: synthetic waveforms, Phys. Earth and Planet. Int., 30, 242-259, 1982.
Smith, M. L., and F. A. Dahlen, The period and Q of the Chandler wobble, Geophys. J. R. astr. Soc., 64, 223-281, 1981.
Spence, W., Relative epicenter determination using P-wave arrival-time differences, Bull. Seism. Soc. Am., 70, 171-183, 1980.
Spudich, P. K. P., and D. V. Helmberger, Synthetic seismograms from model ocean bottoms, J. Geophys. Res., 84, 189-204, 1979.
Spudich, P. K. P., The deHoop-Knopoff representation theorem as a linear inverse problem, Geophys. Res. Lett., 7, 717-720, 1980.
Stein, S., and J. A. Nunn, Analysis of split normal modes fo the 1977 Indonesian eathquake, Bulll. Seism. Soc. Am., 71, 1031-1048, 1981.
Stevens, J. L., Seismic radiation from the sudden creation of a spherical cavity in an arbitrarily prestressed elastic medium, Geophys. J. R. astr. Soc., 61, 303-328, 1980.
Stevens, J. L., The growing spherical seismic source, Geophys. J. R. astr. Soc., 69, 121-135, 1982.
Stifler, J. F., and B. A. Bolt, Eigenvibrations of laterally inhomogeneous Earth models, Geophys. J. R. astr. Soc., 64, 201-221, 1981.
Stoffa, P. L., B. Buhl, J. B. Diebold, and F. Wenzel, Direct mapping of seismic data to the domain of intercept time and ray parameter - A plane-wave decomposition, Geophys., 46, 255-267, 1981.
Stoffa, P. L., J. B. Diebold, and P. Buhl, Velocity analysis for wide aperture seismic data, Geophys. Prosp., 30, 25-57, 1982.
Strelitz, R. A., The interpretation of moment tensor inversions, Identification of Seismic Sources - Earthquake or Underground Explosion, E. S. Huseby and S. Mykkeltveit, eds., D. Reidel Publ. Co., Boston, 273-275, 1981.
Strick, E., Application of the general complex compliance model to the direct-detection problem, Geophys. Prosp., 30, 401-412, 1982.
Strick, E., and F. Mainardi, On a general class of constant-Q solids, Geophys. J. R. astr. Soc., 69, 415-429, 1982.
Stuart, W. D., and G. M. Mavko, Earthquake instability on a strike-slip fault, J. Geophys. Res., 84, 2153-2160, 1979.
Stump, B. W., Inveestigation of seismic sources by the linear inversion of seismograms, Ph D. Dissertation, University of California, Berkley, 1979.
Stump, B. W., and L. R. Johnson, The effect of Green's functions on the determination of source mechanisms by the linear inversion of seismograms, Identification of Seismic Sources - Earthquake or Underground Explosion, E. S. Huseby and S. Mykkeltveit, eds., D. Reidel Publ. Co., Boston, 255-267, 1981.
Stump, B. W., and L. R. Johnson, Higher-degree moment tensors - the importance of source finiteness and rupture propagation on seismograms, Geophys. J. R. astr. Soc., 69, 721-743, 1982.
Suteau, A. M., and J. H. Whitcomb, A local earthquake coda magnitude and its relation to duration, moment M_0, and local Richter magnitude M_L, Bull. Seism. Soc. Am., 69, 353-368, 1979.
Swingler, D. N., A comparison between Burg's maximum entropy method and a nonrecursive technique for the spectral analysis of deterministic signals, J. Geophys. Res., 84, 679-685, 1979.
Swingler, D. N., Burg's maximum entropy algorithm versus the discrete Fourier transform as a frequency estimator for truncated real sinusoids, J. Geophys. Res., 85, 1435-1438, 1980.
Taner, M. T. , F. Koehler, and R. E. Sheriff, Complex seismic trace analysis, Geophys., 44, 1041-1063, 1979.
Tanimoto, T., Cagniard de-Hoop method for a Haskell type vertical fault, Geophys. J. R. astr. Soc., 70, 639-646, 1982.
Taylor, H. L., S. C. Banks and J. F. McCoy, Deconvolution with the ℓ_1 norm, Geophys., 44, 39-52, 1979.
Taylor, S. R., and M. N. Toksoz, Measurement of intersration phase and group velocities and Q using Wiener filtering, Bull. Seism. Soc. Am., 72, 73-91, 1982.
Thatcher, W., and J. B. Rundle, A model for the earthquake cycle in underthrust zones, J. Geophys. Res., 84, 5540-5556, 1979.
Thomson, W. H., J. D. Garmany, and B. T. R. Lewis, Crustal structure near the iceland research drilling project borehole from a seismic refraction survey, J. Geophys. Res., 87, 6383-6388, 1982.
Thrower, E. N., The computation of dispersion curves on layered media, J. Sound Vib., 2, 3, 14-30, 1965.
Thurber, C. H., and W. L. Ellsworth, Rapid solution of ray tracing problems in heterogeneous media, Bull. Seism. Soc. Am., 70, 1137-1148, 1980.
Toksoz, M. N., D. H. Johnston, and A. Timur, Attenuation of seismic waves in dry and saturated rocks: II. Mechanisms, Geophys., 44, 691-711, 1979.
Tolstoy, I., On elastic waves in prestressed solids, J. Geophys. Res., 87, 6823-6827, 1982.
Treitel, S., P. R. Gutowski and D. E. Wagner, Plane-wave decomposition of seismograms, Geophys., 47, 1375-1401, 1982.
Treitel, S., and L. R. Lines, Linear inverse theory and deconvolution, Geophys., 47, 1153-1159, 1982.
Treitel, S., and E. A. Robinson, Maximum entropy spectral decomposition of a seismogram into its minimum entropy component plus noise, Geophys., 46, 1108-1115, 1981.
Turcotte, D. L., R. T. Clancy, D. A. Spence, and F. H. Kulhawy, Mechanisms for the accumulation and release of stress on the San Andreas fault, J. Geophys. Res., 84, 2273-2282, 1979.
Uhrhammer, R. A., Analysis of small seismographic station networks, Bull. Seism. Soc. Am., 70, 1369-1379, 1980.
Uhrhammer, R. A., The optimat estimation of earthquake parameters, Phys. Earth and Planet. Int., 30, 105-118, 1982.
VanArsdale, W. E., Tidal deformation of a viscoelastic body, Geophys. J. R. astr. Soc., 70, 797-805, 1982.
Vanmarcke, E. H., and S. S. Lai, Strong-motion duration and RMS amplitude of earthquake records, Bull. Seism. Soc. Am., 70, 1293-1307, 1980.
Velzeboer, C. J., The theoretical seismic reflection response of sedimentary sequences, Geophys., 46, 843-853, 1981.
Virieux, J., and R. Madariaga, Dynamic faulting studied by a finite difference method, Bull. Seism. Soc. Am., 72, 345-369, 1982.
von Seggern D., A random stress model for seismicity statistics and earthquake prediction, Geophys. Res. Lett., 7, 637-640, 1980.
Wahr, J. M., A normal mode expansion for the forced response of a rotating earth, Geophys. J. astr. Soc., 64, 651-675, 1981.
Wallace, T. C., D. V. Helmberger, and G. R. Mellman, A technique for the inversion of regional data in source parameter studies, J. Geophys. Res., 86, 1679-1685, 1981.
Wallace, T. C., and D. V. Helmberger,

Determining source parameters of moderate-size earthquakes from regional waveforms, Phys. Earth and Planet. Int., 30, 185-196, 1982.
Wang, C.-Y., Wave theory for seismogram synthesis, Ph.D. Dissertation, Saint Louis University, Saint Louis, Missouri, 1981.
Wang, C. -Y., and R. B. Herrmann, A numerical study of P-, SV-, and SH-wave generation in a plane layered medium, Bull. Seism. Soc. Am., 70, 1015-1036, 1980.
Ward, S. N., Ringing P waves and submarine faulting, J. Geophys. Res., 84, 3057-3062, 1979.
Ward, S. N., Body wave calculations using moment tensor sources in spherically symmetric, inhomogeneous media, Geophys. J. R. astr. Soc., 60, 53-66, 1980.
Ward, S. N., A technique for the recovery of the seismic moment tensor applied to Oaxaca, Mexico eartquake of November 1978, Bull. Seism. Soc. Am., 70, 717-734, 1980.
Ward, S. N., Relationships of tsunami generation and an earthquake source, J. Phys. Earth, 28, 441-474, 1980.
Ward, S. N., A technique for the recovery of the seismic moment tensor applied to the Oaxaca, Mexico earthquake of November 1978, Bull. Seism. Soc. Am., 70, 717-734, 1980.
Ward, S. N., On elastic wave calculations in a sphere using moment tensor sources, Geophys. J. R. astr. Soc., 66, 23-30, 1981.
Ward, S. N., Simplified bodywave source terms with one application in moment tensor recovery, Identification of Seismic Sources - Earthquake or Underground Explosion, E. S. Huseby and S. Mykkeltveit, eds., D. Reidel Publ. Co., Boston, 269-272, 1981.
Ward, S. N., On tsnami nucleation. 1. A point source, J. Geophys. Res., 86, 7895-7900, 1981.
Ward, S. N., On Tsunami nucleation. II. An instantaneous modulated line source, Phys. Earth Planet. Inter., 27, 273-285, 1982.
Ward, S. N., Earthquake mechanisms and tsunami generation: the Kurile Islands event of 13 October 1963, Bull. Seism. Soc. Am., 72, 759-777, 1982.
Weertman, J., Inherent instability of quasi-static creep slippage on a fault, J. Geophys. Res., 84, 2146-2152, 1979.
Weertman, J., Unstable slippage across a fault that separates elastic media of different elastic constants, J. Geophys. Res., 85, 1455-1461, 1980.
Weglein, A. B., W. E. Boyse, and J. E. Anderson, Obraning three-dimensional velocity information directly from reflection seismic data: An inverse scattering formalism, Geophys., 46, 1166-1120, 1981.
White, J. E., Computed waveforms in transversely isotropic media, Geophys., 47, 771-783, 1982.
White, R. S., and R. A. Stephen, Compressional to shear wave conversion in oceanic crust, Geophys. J. R. astr. Soc., 63, 547-565, 1980.
Widess, M. B., Quantifying resolving power of seismic systems, Geophys., 47, 1160-1173, 1982.
Winkler, L., Catalog of U.S. earthquakes before the year 1850, Bull. Seism. Soc. Am., 69, 569-602, 1979.
Wong, H. L., Effect of surface topography on the diffraction of P, SV, and Rayleigh waves, Bull. Seism. Soc. Am., 72, 1167-1183, 1982.
Woodhouse, J. H., The coupling and attenuation of nearly resonant multiplets in the Earth's free oscillation spectrum, Geophys. J. R. astr. Soc., 61, 261-283, 1980.
Woodhouse, J. H., Efficient and stable methods for performing seismic calculations in stratified media, Physics of the Earth's Interior, Course LXXVIII, A. Dziewonski and E. Boschi, eds., North Holland Publ. Co., New York, 127-151, 1980.
Woodhouse, J. H., A note on the calculation of travel times in a transversely isotropic Earth model, Phys. Earth and Planet. Inter., "5, 357-359, 1981.
Woodhouse, J. H., The excitation of long period seismic waves by a source spanning a structural discontinuity, Geophys. Res. Lett., 8, 1129-1131, 1981.
Woodhouse, J. H., The joint inversion of seismic waveforms for lateral variations in the earth's structure and earthquake source parameters, Physics of the Earth's Interior, Course LXXXV, H. Kanamori and E. Boschi, eds., North Holland Publ. Co., New York, in press, 1982.
Woodhouse, J. H., and T. P. Girnius, Surface waves and free oscillations in a regionalized earth model, Geophys. J. R. astr. Soc., 68, 653-673, 1982.
Wyatt, K. D., Syntheric vertical seismic profile, Geophys., 46, 880-891, 1981.
Yacoub, N. K., Seismic yield estimates from Rayleigh-wave source radiation pattern, Bull. Seism. Soc. Am., 71, 1269-1286, 1981.
Yilmaz, O., and J. F. Claerbout, Prestack partial migration, Geophys., 45, 1753-1779, 1980.
Yuen, D. A., and W. R. Peltier, Normal modes of the viscoelastic earth, Geophys. J. R. astr. Soc., 69, 495-526, 1982.
Yuen, D. A., R. Sabadini, and E. V. Boschi, Viscosity of the lower mantle as inferred from rotational data, J. Geophys. Res., 87, 10,745-10,762, 1982.

(Received November 8, 1982; accepted April 29, 1983.)

REVIEWS OF GEOPHYSICS AND SPACE PHYSICS, VOL. 21, NO. 6, PAGES 1308-1318, JULY 1983
U.S. NATIONAL REPORT TO INTERNATIONAL UNION OF GEODESY AND GEOPHYSICS 1979-1982

STRONG-MOTION SEISMOLOGY

David M. Boore

U. S. Geological Survey, 345 Middlefield Road, Menlo Park, CA 94025

Although this is the first review on this topic to appear in a quadrennial report, the roots of strong-motion seismology extend back to at least 1932, when far-sighted engineers in the Seismological Field Survey of the U. S. Coast and Geodetic Survey installed rugged, fieldworthy instruments designed to make on-scale recordings of large earthquakes (Carder, 1964); these instruments are called accelerographs, for their output closely mimics ground acceleration (Hudson,1979). The original instruments and their offspring have provided a wealth of information about ground motions of direct use to engineers. Due in large part to the continued devotion of the Seismological Field Survey (now part of the Branch of Engineering Seismology and Geology at the U. S. Geological Survey), the number of recordings has increased substantially, particularly in the last two decades, and multiple recordings of a few California earthquakes have provided the data necessary to begin to unravel the complexities of the ground motions and to predict these motions on an empirical basis. Although seismologists used accelerograph records in studies of earthquake energy and ground motion attenuation as long ago as 1942 (Gutenberg and Richter, 1942, 1956), widespread seismological use of the records began with Aki's (1968) analysis of the 1966 Parkfield earthquake. The field of strong-motion seismology has been especially vigorous since 1971, when the San Fernando, California, earthquake produced close to 100 on-scale records of the ground motion within 150 km of the faulting. The rapid growth of the field in the last decade was helped by the social concern with earthquake hazard reduction and by regulatory processes intended to protect the environment and the population from the failure of such engineered structures as nuclear power plants and large dams.

Paper number 3R0397.

A major task of strong-motion seismology is the study and prediction of potentially damaging ground shaking; practically speaking, this means predictions of ground motion within several tens of kilometers from earthquakes with moments larger than about 3×10^{23} dyne-cm. To do this requires a truly interdisciplinary approach, with contributions from both seismologists and engineers working on subjects as diverse as theoretical models of crack propagation and experimental nonlinear soil behavior. Because so many different areas of research pertain to strong-motion seismology, this review has been difficult to organize and has resulted in a voluminous bibliography, of which only a fraction of the papers will be specifically cited. The paper begins with a review of data acquisition and processing, followed by studies based on empirical analyses of strong-motion data. These include investigations of the character of strong motion, such as the correlation between components and the prediction from regression studies of strong ground motion as a function of source size and distance from source to site. After this will be a number of topics related to the prediction of strong ground motion, following the usual order of source, propagation path, and site response. Consideration of these topics forms the bulk of the review. The final section deals briefly with the important and difficult problem of prediction of ground motion in the central and eastern United States, where few recordings of motions from damaging earthquakes are available. Because the emphasis in this review is on the prediction of strong ground motion, references to modeling studies using accelerograms from specific earthquakes are not given in a separate section but are distributed throughout the text when their conclusions are relevant to the topic under consideration. In fact, most of them are collected in the subsection of source studies dealing with estimation of source properties.

Because my charge was to review the field from 1979—1982, I have ignored the many contributions made previously (the bulk of which were made between 1971 and 1979). An excellent guide to the